Space Weather Technical Forecast

Issued on Tuesday, 10 October 2023 at 01:25 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Isolated M-class flares likely. Chance G1 Minor Storm intervals day 1-3 (09-11 Oct) from coronal hole fast winds and CME arrival.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Low with frequent C-flares, and peak flare C9.7 at 09/1911 UTC from AR3451 in the northwest. There are eight sunspot regions visible. AR3451 in the northwest is the largest and most magnetically complex, with ongoing slow growth and the persistence of a weak delta spot on its trailer spots. AR3460 is a smaller, but complex region, which has seen ongoing consolidation of its small spots into a more defined trailer and leader spot. A moderately strong delta spot is present on this regions trailer spot. The remaining regions are all smaller and simpler. No Earth-directed CMEs have been detected.

Solar Wind / Geomagnetic Activity: Solar winds as observed at L1 by ACE/DSCOVR have persisted at generally slow wind conditions, with no definitive indication of CH57/- fast winds. The solar wind speed was at background but with a slow rising trend from 310kms to 350km/s. Density varied from around average to below average at times. Total interplanetary magnetic field (IMF) strength, Bt, was weak, below 7nT. The north-south component, Bt, has been largely negative with only brief positive spells, ranging -6 nT to +6 nT. Phi angle was generally positive (away from the Sun) until 09/2100 UTC, then became negative (towards the Sun). Geomagnetic activity has been Quiet to Unsettled (Kp 1-3).

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux was at background levels. GOES16 high energy (greater than 2MeV) electron flux was Background to Moderate, peaking 276 pfu at 08/1620 UTC. Associated 24-hour fluence was below the Active (1e8 integrated pfu) threshold. The observation at 09/2100 UTC was 3.49e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity is expected with isolated M-flares likely. There is a slight chance of very isolated X-flare from either AR3451 or AR3460

Solar Wind / Geomagnetic Activity: There is one Earth-directed CME, with expected arrival either late day 2 or early day 3 (11-12 Oct). Current slow wind is likely to transition into the fast winds of CH57/- during day 1 (10 Oct), followed by the fast winds of CH58/- later day 1 or day 2 (10-11 Oct). This likely bringing peak winds of around 500-600 km/s. Quiet geomagnetic activity will increase to Unsettled to Active at times of days 1-3 (10-12 Oct) with the onset of the fast winds or more likely with the CME arrival. There is a slight chance of G1 Minor Storms day 1-2 (10-11 Oct) with the fast wind enhancements, and a chance G1-G2 Minor Storm intervals day 2-3 (11-12 Oct) with any CME arrival.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is most likely to remain at background levels, with a slight chance of enhancements, mainly if any notable flares from AR3451 or perhaps AR3460 occur. High energy electron flux (greater than 2MeV) is forecast to be at background to moderate levels throughout, dropping out with any fast wind or CME arrivals before potentially increasing again day 4 (12 Oct). Electron fluence is

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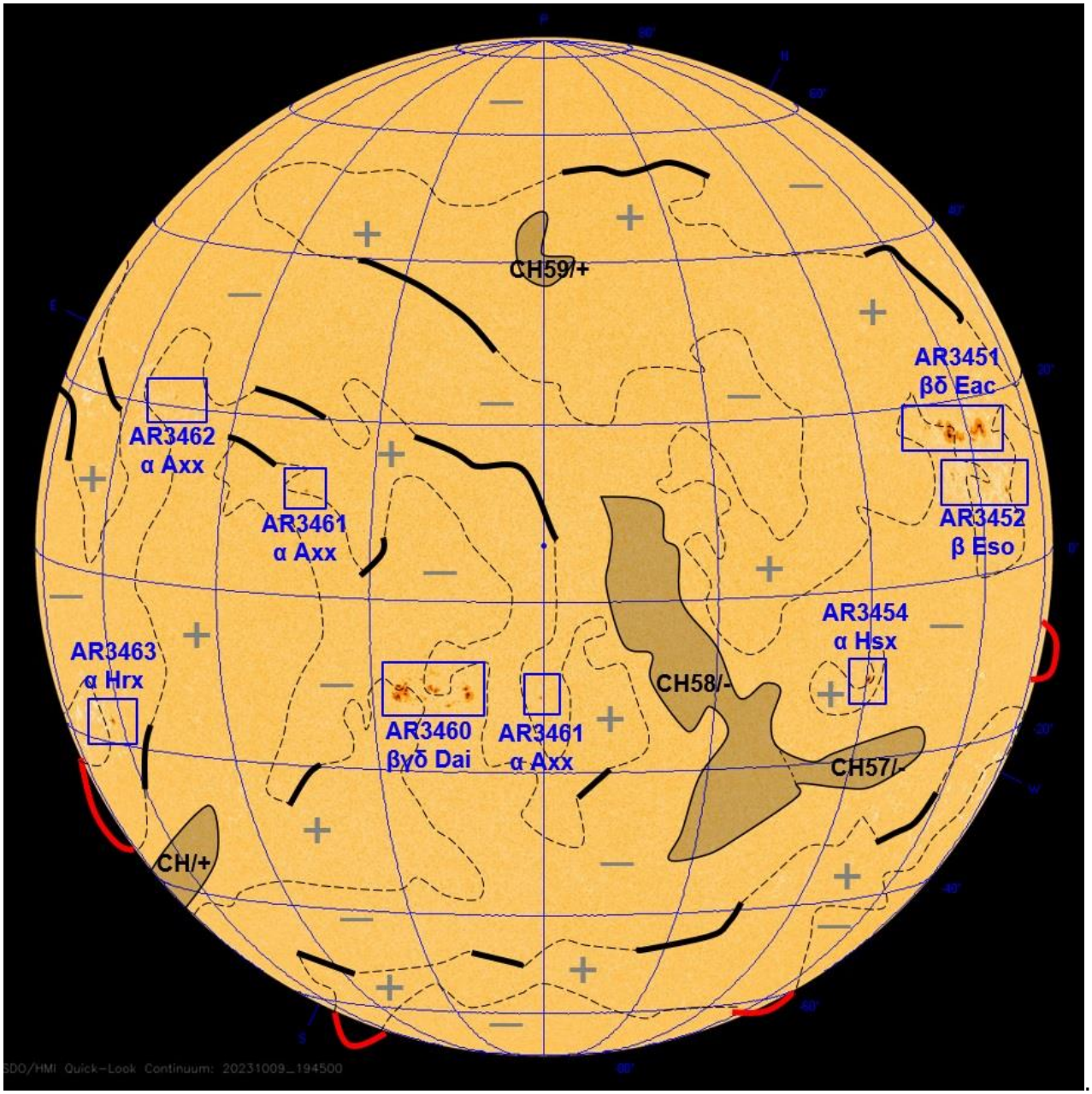
expected to remain below the Active (1e8 integrated pfu) threshold.

Figure 1. Solar Analysis Valid 09/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A CME associated with the C6.6 flare of AR3460 at 08/0339 UTC, is forecast to arrive at Earth late day 3 or early day 4 (11-12 Oct).

Slow wind conditions are expected at first, before Earth likely move into any fast wind from CH57/- early day 1 (10 Oct). A further transition is then expected later day 1 or early day 2 (10-11 Oct) into the broader high speed stream (HSS) from CH58/-, peaking at elevated levels of 500-600km/s, as suggested by MOSWOC enlil. These winds only gradually easing towards background day 4 (13 Oct)

Quiet geomagnetic activity will increase to Unsettled to Active on day 1 (10 Oct) and perhaps into day 2 (11 Oct) following the arrival of any CIR (co-rotating interactivity region) ahead of the fast wind enhancements. Negative coronal holes are less likely to give strong connections near the September equinox (Russell-McPherron effect) however there is still a chance of isolated G1 intervals. Later day 2 or early day 3 (11-12 Oct), activity will likely become Active with a chance of G1-G2 Minor/Moderate storms intervals due to any CME arrival. Activity easing to mainly Quiet day 4 (13 Oct).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	30	30	1
Strong	G3	No	1	5	5	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
08/1435	Partial	C6.6 AR3460	SE	460 km/s	Late 11/early 12 Oct	Arrival dependent on CH fast wind

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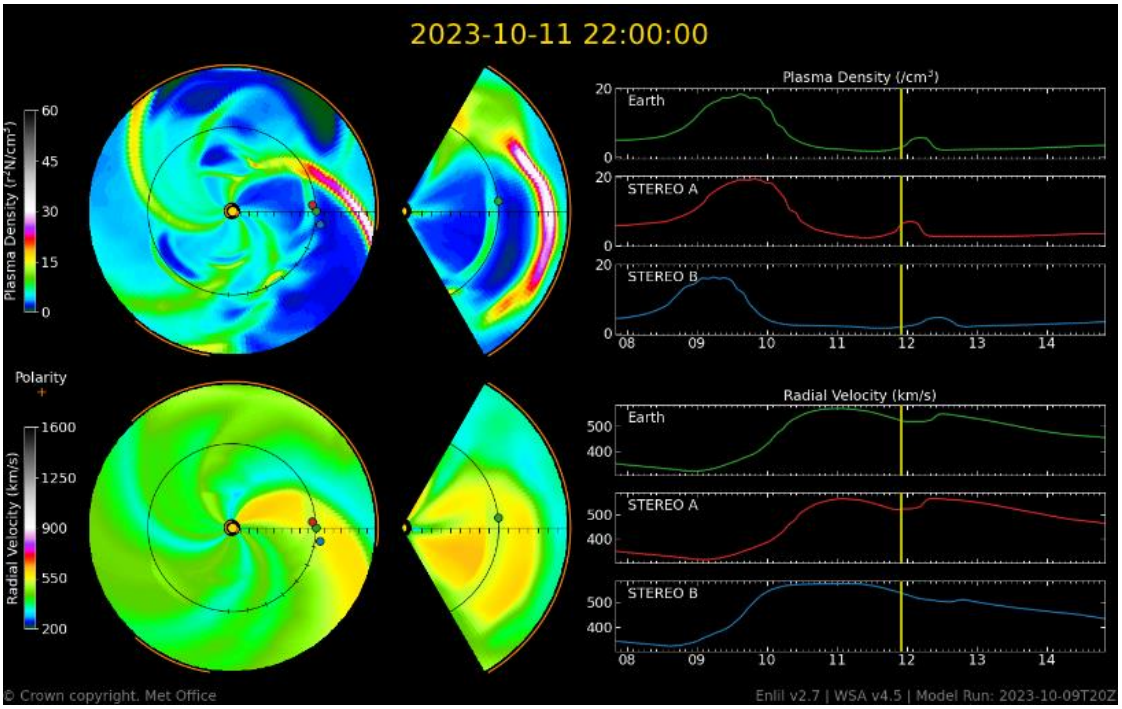
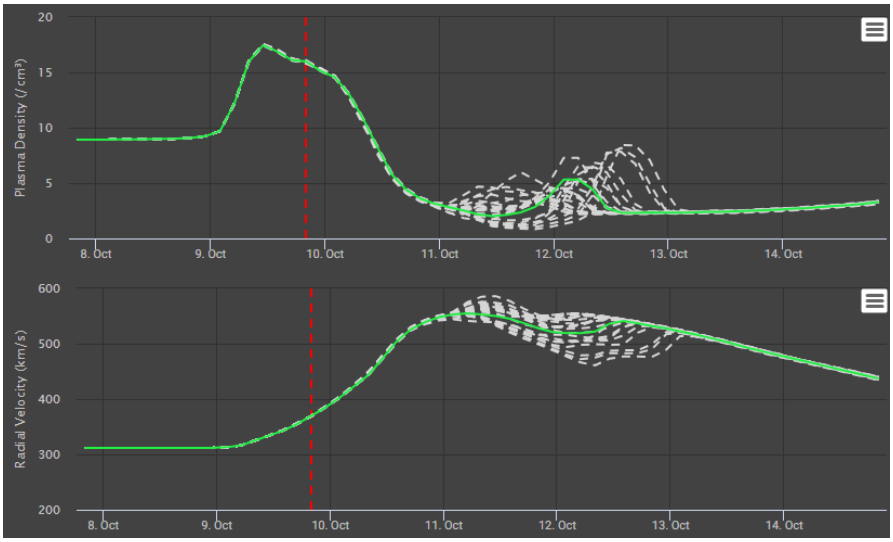
Figure 2: Enlil showing CH enhancement and potential CME arrival





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Radio Blackouts - X-Ray Flares:

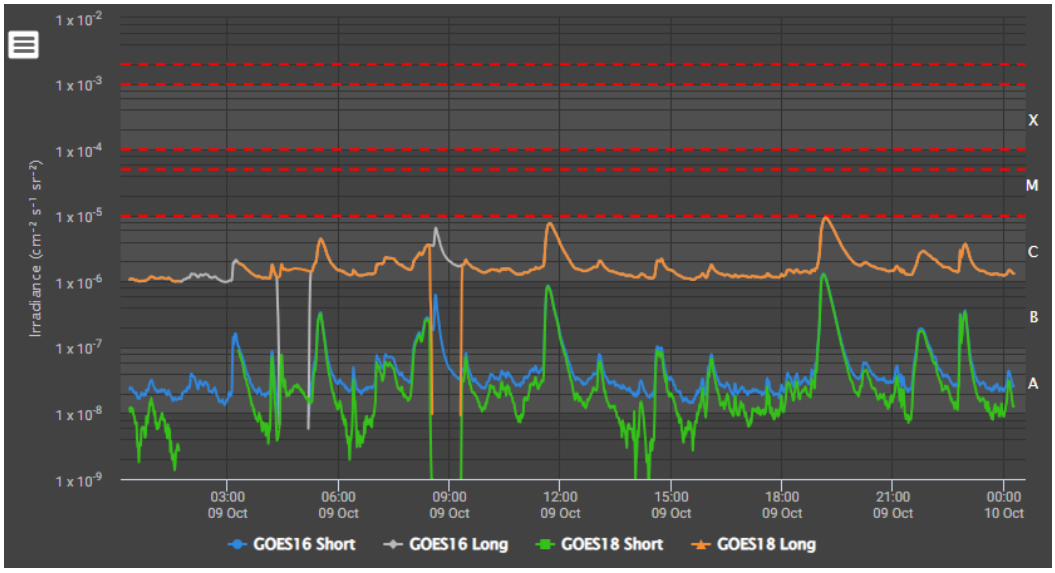
Solar Activity is forecast to be Low to Moderate with an ongoing chance of isolated M-class flares. There is a slight chance of activity increasing to High due to a very isolated X-class flare, from either AR3451 or AR3460

AR3451 is a relatively simple east to west aligned group, now approaching the northwest limb, however this does contain a delta spot on its moderately sized trailer. This additional complexity brings an increased potential for flaring, with a slight chance of X-class flares. This region has also seen some slow growth of intermediate spots. AR3460 is a smaller group, in the southeast disc, however this is also seeing growth, with its component small spots consolidating into a standard east-west trailer-leader configuration. This also has mixed polarity regions on its asymmetric trailer, with a moderately strong delta spot. This brings an increased risk of flaring, with a slight chance of X-class flares.

The other spots on the disc are all smaller and simpler, and largely stable or decaying. However far-side produces suggest the potential for further region or regions to rotate onto the disc from over the northeast limb on day 1 (10 Oct).

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	60	55	50	45
Very Active	R3 to R5 X Class	No	10	10	5	5

Figure 3: GOES-16/18 X-ray Flux



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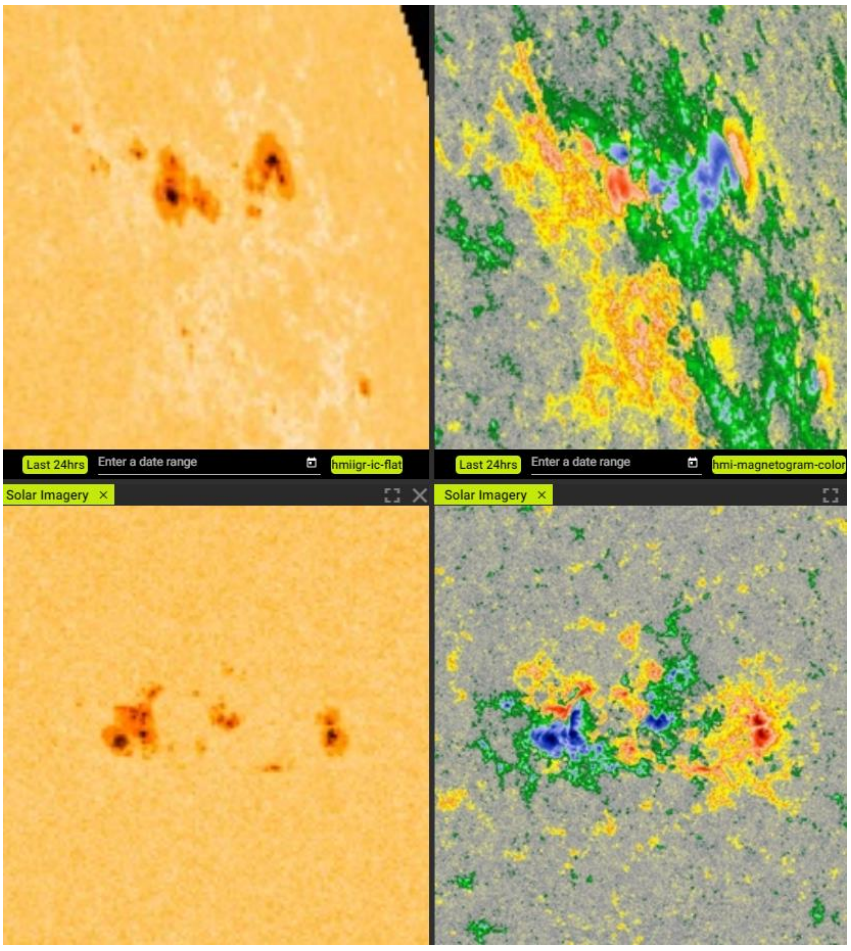
Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is most likely to persist at background levels. AR3451 has developed a small delta spot however, and given its location on the northwest disc, this brings an increased potential for proton flux to rise should any notable flares occur from this region. AR3460 also brings an increasing potential for protons events, as it also moves into the western disc.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: SDO hmi intensitygram (left) and Magnetogram (right) of AR3451 (top, includes AR3452) and AR3460 (bottom)



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High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) as observed by GOES16 has peaked at moderate levels at the diurnal maximum in recent days, but is expected to continue at mainly background. Any fast wind arrival from CH57/58, alongside the potential CME arrival late day 2 or day 3 (11-12 Oct) is expected to initially suppress observed values, but increase electron flux through the Van Allen Belts at lower orbits. This may lead to the observed flux at GEO increasing as solar wind pressure eases, bringing a chance of Moderate, perhaps peaking High by day 4 (13 Oct).

Electron fluence is forecast to be well below the Active (1e8 integrated pfu) level throughout, however, albeit with an increasing trend from late day 3 or day 4 (12-13 Oct). MOSWOC REFM output is currently giving good guidance.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	5	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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